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(54) **A method and apparatus for preparing fuels or fuel mixtures**

(57) During processing of the materials or mixtures of materials to produce a fuel they are exposed to a percussion treatment, and are simultaneously made subject to high accelerations. The material treated preferably comprises a solid and a liquid component, such as brown coal, heavy fuel oil and water.

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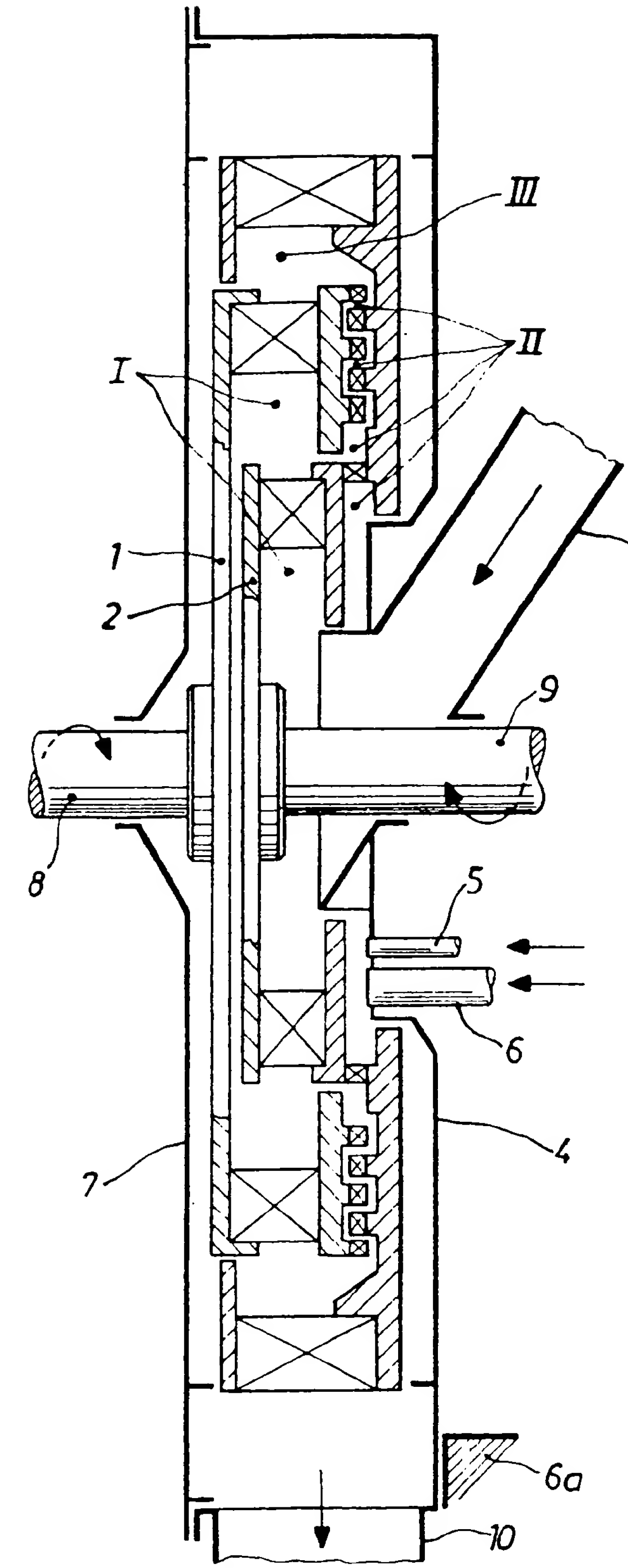

SPECIFICATION

A method of preparing fuels or fuel mixtures and an apparatus for the production of fuels or fuel mixtures

The present invention relates to a method, at which organic or inorganic materials or mixtures of materials are made subject to a treatment which increases the practically utilizable calorific value of such materials or mixtures of materials.

It is desirable to increase the calorific value of fuel mixtures, specifically such having one solid component and one liquid component intermixed with each other.

In the art of energetics it is known to utilize fuels which are a combination of a solid component (e.g. stone coal, anthracite, brown coal, splint coal, sometimes also a mixture thereof) and a liquid component (e.g. heavy fuel oil and water). The composition of such fuel mixtures which are practically utilized varies within broad ranges. The relative amount of water in such mixtures is usually at a value of 5—20% in relation to the total mass of the mixture. The content of the solid component, for instance, of the stone coal as well as of the heavy fuel oil, is usually not lower than 10% in relation to the total mass of the mixture, whereby a decrease of one of the components, for instance, of the stone coal in such a mixture is accompanied by a corresponding increase of the heavy fuel oil.

There is a rising use of fuel mixtures instead of the pure liquid components, such as of the heavy fuel oil, while such mixtures are markedly cheaper than the liquid component thereof as such.

The main drawback of known fuel mixtures which contain a solid and a liquid component is the lower calorific value of such mixtures.

Previously disclosed methods aiming at the improvement or an increasing, respectively, of the calorific value of such fuel mixtures have been based on the utilization of solid components having a as high as possible calorific value (e.g. stone coal), whereby at the same time the portion of the heavy fuel oil has been increased relative to the other components of such mixture. The calorific value Q of the fuel mixtures (measured in e.g. kJ/kg) is thereby calculated based on the calorific value of the solid component (heavy fuel oil) and from the content portion of these components in the mixture whereby water is omitted,

$$Q_{mixture}=A\times Q_{solid\ component}+B\times Q_{liquid\ component},$$

whereby A and B represent correspondingly the contents of the solid component and liquid component in the mixture given in weight percents.

According to known methods of preparing fuel mixtures which contain solid components and liquid components the solid component which, for instance, has been ground to a powder is intermixed in mechanical mixing apparatuses, e.g. in turbine impeller mixers with liquid components.

The drawback of known methods is an insufficient intermixing of the fuel components due to which such fuel mixture stratifies relatively soon, usually after a few hours into separate layers if such mixture is not continuously agitated. The need of a continuous agitating of such mixtures renders its application extremely complicated. In order to eliminate such drawback stabilizing components have been added to such mixtures, which stabilizing components have preferably been chemical materials. Usually the content of such stabilizing additive amounts to some percents of the total mass of the fuel mixture. By means of mentioned additives the stability of the fuel mixture can be markedly increased—the stratification into separate layers takes place after expiration of several days, usually two or three days—however, such stabilizing agents lead to a considerable increase of the price of such fuel mixtures and do not sufficiently solve the problems of providing stable mixtures.

By following the previously known methods for the preparation of above mentioned fuel mixtures, for instance, an intermixing of the components in mechanical mixing apparatuses fuel mixtures are arrived at which feature a factual calorific value which corresponds to the calorific value calculated in accordance with above mentioned formula. Accordingly, the water component, a part of mentioned fuel mixtures, does not take part in the combustion process. This fact is a considerable drawback of the hitherto known methods of preparing fuel mixtures and regarding the increase of their calorific value.

Summary of the invention

Hence, it is an object of the present invention to provide a method which increases or improves, respectively, the utilizable calorific value of fuels or fuel mixtures, which comprise solid components and liquid components.

The present invention is based on the observation that by an application of forces of inertia onto the materials such as high accelerations of gravity (e.g. 10^8g) the structure of the materials changes such that at further reactions between the individual materials which have been acted upon by large forces of inertia a certain additional energy is generated in comparison with such amount of energy which is effective in materials which have not been treated according to the previously mentioned procedure.

In order to implement mentioned objects the method according to the invention foresees a percussion treatment of the individual components or of the components of the fuel mixture. Preferably the treatment is effected by acting upon the particles of the mixture by an at least $10^8\times$acceleration of gravity whereby, for instance, during less than 10^{-2} seconds an amount of energy of 40 kj is transferred to each kilogram of the fuel mixture.

Such a treatment can be practiced in that, for instance, a series of explosion percussions,

electrical discharge series or a treating of the material or material mixture by means of mechanical percussions is carried out in apparatuses of an electrical governed or rotor design.

A further object of the invention is to provide an apparatus which allows a preparing of fuel mixtures in accordance with above mentioned method.

Brief description of the drawing

The present invention will be more fully understood by reference to the following detailed description thereof, when read in conjunction with the attached drawing, and wherein:

The single Fig. depicts schematically an apparatus in accordance with a preferred embodiment of the present invention.

Practical tests have shown that when treating a fuel mixture by a series of mechanical percussions, which fuel mixture is composed of 41.7% stone coal, 41.7% heavy fuel oil and 16.7% water and if an amount of energy exceeding 108 kJ/kg is transferred to the fuel mixture during 10^{-3} seconds, an increase of the utilizable calorific value of the fuel mixtures will amount to about 5443 kJ/kg, i.e. an increase which is about 50 times higher than the amount of energy needed for the treatment proper.

The utilizable increase of the calorific value of a fuel mixture treated accordingly is influenced in part also by the relation between the components of the mixture and the physical-chemical properties of the components. Therefore, the economical operation for a practical application must be chosen experimentally by proceeding from predetermined materials.

During a combustion of the fuel mixtures treated in accordance with the described method the water also takes part in the combustion as active component. The combustion of these mixtures is more complete than that of analog fuel mixtures which have not been treated. The treated mixtures are extremely stable during a storing thereof.

Disintegrator apparatuses similar to DE-OS 29 26 042 which are applied for the treatment of coal for the gasification and hydrogenation thereof are suitable for carrying out above method.

One of such disintegrator apparatuses for a dispersion of materials comprises two counterrotating wheel disks arranged at a distance from each other, onto to which there are mounted rodlike percussion elements arranged in several rows along the circumference of the wheel disk, which percussion elements intermesh row-wise alternatingly, and which apparatuses comprise a central material infeed and a surrounding housing having a hopper discharge whereby the wheel disks have a radius of more than about 50 cm.

It is known that the construction of the disintegrator apparatus for the dispersion and mechanical activation of stone coal (anthracite), brown coal (splint coal), such as the apparatus in accordance with mentioned DE-OS 29 26 042, guarantees an excellent technological treating (activation) of the stone coal, due to which subsequent processes of gasification and hydrogenation proceed more ecomonically.

It has been proven now, that such disintegrator apparatuses used for a mechanical activating of the stone coal allow an excellent pretreating of stone coal also for use in fuel mixtures which contain solid as well as liquid components and accordingly guarantee a substantially improved stability of these mixtures during a prolonged storage thereof.

Experience has shown that at the design of the rotors of the disintegrator apparatus for activating the stone coal such an operation must be chosen, in which the coal particles experience at least three immediately succeeding percussions at a speed of percussion in the range of at least 50 m/s in the first rotor circle and of least 150 m/s in the last rotor circle. In such case the mechanical activation of the coal is guaranteed in a technological favorable extent. On the other hand, due to experiences made the economical working conditions of the mechanical activation of the stone coal (anthracite, brown coal, splint coal) can be characterized by the amount of energy which is necessary for the treating thereof. Accordingly, a specific expenditure on electrical energy in the range of 10—20 kwh/t is needed.

Experience has shown that regarding a mechanical activating of liquid fuels (diesel oil, heavy fuel oils) and water in disintegrator apparatuses percussion speeds should be chosen preferably which exceed 150 m/s (for instance, percussion speeds in the range of 150—250 m/s). Furthermore, it is advantageous when treating above mentioned liquids to treat such by an amount of percussions which is about twice the amount used by stone coal and many other solid materials. Correspondingly, it is desirable to provide in disintegrator apparatuses intended for a mechanical activation of liquids treating members of at least six circles. If the suitable operation of the disintegrator apparatus for an activation of liquid fuels is characterized by the energy consumed during the activating process it may be said that such a design of rotors must be selected which transmits at least 20 kwh/t to the liquid fuel of water.

When utilizing the previously known disintegrator apparatuses the production of activated fuel mixtures which contain solid components and liquid components is only possible if the stone coal is activated in one specific disintegrator apparatus and the liquid components of the fuel are activated in another specific disintegrator apparatus, for instance, fuel oil and water, whereafter then the fuel mixture itself is intermixed in a third apparatus. Such great number of apparatuses is due to the drawbacks of the designs of previously known disintegrator apparatuses.

The previously known disintegrator

apparatuses are now improved by the apparatus in accordance with the present invention, in that it is not possible to produce activated fuel mixtures which contain solid components and liquid components in one and the same disintegrator apparatus.

In order to achieve this object the present invention provides a design, according to which the working element, i.e. the rotors of the disintegrator comprise three working zones, of which two working zones are intended for an independent parallel treating of the solid components and the liquid components, and in which the last rotor circle forms, however, the third treating zone, in which a joint treating of all components as well as the intermixing thereof takes place. In such a design (see drawing) a speed of 3000 rpm is preferred for the rotor half mounted to the left shaft whereby the diameter of this rotor half is within the range of 800—900 mm. The rotor half mounted to the right hand shaft features preferably a speed of 1500 rpm whereby it is advantageous to choose a size regarding the outer diameter of this rotor half and accordingly regarding the outer diameter of the complete rotor set at a value below 1200 mm.

It is also possible to use other combinations of speeds if it is kept in mind that the sum of the linear speeds present at the central lines of the two last percussion lines of zone (II) of the pretreatment of the liquid components amounts to least 200 m/s.

The drawing shows an embodiment of the inventive apparatus shown in a schematical axial section.

Due to the design shown in the Fig. it is possible to design zones for the pretreatment of solid components having more than two percussion circles as well as working zones of the final treatment and intermixing having more than one percussion circle by proceeding from disintegrator apparatuses of previously known design.

The design of the percussion elements of the percussion circles is arbitrary. Practically all previously known percussion elements of geometrical form can be used.

According to the shown design two metering tubes for a metering of the liquid components, for instance, heavy fuel oil and water, are mounted to the housing of the disintegrator apparatus in addition to the usual infeed hopper which is used for metering the solid components, whereby the metering tubes lead into the working zone (II) of the rotors, in which the liquid components are pretreated.

The shown design consists of two rotor halves 1, 2 and of concentric percussion circles arranged thereon, of which a part is intended for a pretreating of the solid components (in the I. working zone), a part for the pretreating of the liquid components (in the II. working zone) and one percussion circle for a joint treating and intermixing of all components (in the III. working zone).

The hopper 3 for the infeed of solid components is mounted to the central part of the housing 4. The metering tubes 5, 6 for the liquid components are mounted to the housing lower relative to the hopper 3. The housing 4 of the apparatus is mounted to a stationary frame 6a, in which also the driving means, gears, etc. of the apparatus and other general structural elements are mounted. The wall 7 of the housing 4 is dismountable in order to allow a pulling away from each other of the rotor halves of the apparatus (in order to exchange or repair the rotors). The rotor halves 1, 2 are mounted to the shafts 8, 9 or flanged thereto, respectively, such that the rotor halves may counterrotate relative to each other. The working zone I of the rotors is provided with two percussion circles, the working zone II is provided with six and the working zone III is provided with one percussion circle.

At the operation of the apparatus the rotor halves are rotated by the gear of the apparatus such that they counterrotate and the components of the mixtures are metered in a smooth, uninterrupted stream into the corresponding infeed hopper or infeed tubes 3 and 5, 6, respectively. The solid component (or solid components) of the mixture, for instance, stone coal, which is usually present in form of lumps, is ground into powder and mechanically activated by rapidly succeeding percussions in the I. and thereafter in the III. working zone of the rotors. The liquid components, for instance, heavy fuel oil and water, are mechanically activated in the II. working zone of the rotors and thereafter intermixed within the III. working zone of the rotors with the solid components whereby the intermixing of the components proceeds also during the flowing of the particles of the mixture at the radial surface of the apparatus. The finished, i.e. treated, fuel mixture exits through the outlet 10 out of the housing (is centrifuged or spun out). A characteristic of the activated fuel mixtures produced in such procedure is an excellent stability. Even after a storage for several weeks such mixtures do not stratify, they do not separate into layers. Furthermore, the activation allows a decreasing of the flash point of the mixtures and secures a smooth combustion in boiler apparatuses.

In general the liquid components of the fuel mixture—e.g. heavy fuel oil and water—are metered in the shown apparatus between the inner circles of the working member (rotor) of the disintegrator such that the particles of the liquid components of the mixture receive up to two percussions. In such case a grinding or pulverizing, respectively, of stone coal (anthracite, brown coal, splint coal) only takes place in the first percussion circles of the working element (rotor) of the disintegrator apparatus and the intensive mixing of mixture components takes place in the last percussion circles together with the additional pulverization of the solid component.

The applied number of percussions during the

treating of the liquid components—one or two percussions—is chosen by means of the metering of these components correspondingly either between the last percussion circle or second to the last percussion circle. In case of relatively heavy fuel oils it is advantageous to meter the fuel oil between the second to the last percussion circle, i.e. to insure up to two percussions. A practical embodiment and realization of the method have proven that the above described method for the production of fuel mixtures allows a gaining of a fuel mixture which does not lose its stability during at least three weeks by practically the same expenditure on energy which is needed by mechanical mixing procedures.

While there are shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims, accordingly.

Claims

1. A method of preparing a fuel by a processing of materials or mixtures of materials comprising an exposing of said materials or said mixtures of materials to a mechanical treatment and of exposing such processed products to high accelerations.

2. The method of claim 1, wherein said mechanical treatment is effected in a disintegrator.

3. The method of claim 1, wherein said mechanical treatment is a percussion treatment, and wherein further the product being treated is subjected to high accelerations.

4. The method of claim 1 for the preparation of fuel mixtures, specifically such containing solid materials such as stone coal, brown coal and similar and liquid materials such as heavy fuel oil, water and similar, wherein all components of the fuel mixture are simultaneously treated by percussions.

5. The method of claim 4, wherein the treatment is effected such that a at least 10^8 times acceleration of gravity takes effect, whereby during less than 10^{-2} seconds an amount of energy of at least 40 kJ is transferred to each kilograms of said fuel mixture.

6. The method of claim 4, wherein said simultaneous treating of the various components of said mixture is effected at least partly in separate stations and at selected conditions.

7. A method of producing fuel mixtures containing solid and liquid components, comprisng a treating of said mixtures by percussion, during which said solid components are treated separately from said liquid components, and wherein a joint treatment is effected during the intermixing of all said components.

8. An apparatus for the preparation of a fuel by a processing of materials or mixtures of materials, in which said materials or mixtures of materials are made subject to a mechanical treatment and exposed to a high acceleration, which apparatus is provided with two counter-rotating rotors arranged at a distance from each other having mounted thereupon a plurality of percussion elements arranged in a plurality of rows distributed along the circumference of said rotors and which alternatingly intermesh row-wise, provided further with a central material infeed and a housing having a discharge, wherein said rotors define a first, a second and a third working zone for the treatment of fuel mixtures which contain solid and liquid components, which said first working zone intended for a pretreating of the solid components of said mixture comprises two percussion circles, which said second working zone intended for an activating pretreating of the liquid components of said mixture extends parallel to said first working zone and is provided with at least more than two, for instance, six percussion circles, and which said third working zone intended for a joint treating and intermixing of all components is located following said two zones and is provided with at least one percussion circle.

9. The apparatus of claim 8, wherein said rotors are provided with at least two inlets which lead to two different points into said housing and are arranged such that the infeed tubes for liquid components are located below the infeed hopper for solid components.

10. An apparatus for the production of fuel mixtures containing solid and liquid components, which components are initially separately treated by percussions and thereafter jointly treated during an intermixing thereof, which apparatus is provided with two counter-rotating rotors arranged at a distance from each other having mounted thereupon a plurality of percussion elements arranged in a plurality of rows distributed along the circumference of said rotors, and which alternatingly intermesh row-wise, provided further with a central material infeed and a housing having a discharge, wherein said rotors define a first, a second and a third working zone for the treatment of fuel mixtures which contain solid and liquid components, which said first working zone intended for a pretreating of the solid components of said mixture comprises two percussion circles, which said second working zone intended for an activating pretreating of the liquid components of said mixture extends parallel to said first working zone and is provided with at least more than two, for instance, six percussion circles, and which said third working zone intended for a joint treating and intermixing of all components is located following said two zones and is provided with at least one percussion circle.

11. The apparatus of claim 10, wherein said rotors are provided with at least two inlets which lead to two different points into said housing and are arranged such that the infeed tubes for liquid components are located below the infeed hopper for solid components.

12. A method of preparing a fuel by processing

materials substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

13. Apparatus for preparing a fuel product substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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